NASA TECH BRIEF

Lewis Research Center

Design Criteria Monograph for Actuators and Operators

A design criteria monograph has been published which is a summary and a systematic ordering of the large and loosely organized body of existing successful design techniques and practices for actuators and operators.

This monograph organizes and presents, for effective use in design, the significant experience and knowledge accumulated by NASA in development and operational programs. It reviews and assesses current design practices, and from them establishes firm guidance for achieving greater consistency in design, increased reliability in the end product, and greater efficiency in the design effort.

The most numerous devices in rocket engine and spacecraft control systems are actuators and their operators. An actuator is a device that converts hydraulic, pneumatic, electrical, or potential energy into mechanical motion; an operator is a device that uses an actuator motion to accomplish a function. Actuators and operators may be designed as separate assemblies; most frequently, however, they are subassemblies as integral components of larger assemblies.

The most commonly used actuator configurations for space-flight service are the linear-motion piston, diaphragm, bellows, and solenoid. These configurations minimize problems associated with fluid leakage, fluid chemical compatibility, large temperature excursions, severe vibration environments, and control of dynamic response. The most commonly used operators are the various configurations of pilot valves, servovalves, and pressure-divider circuits. The extensive use of these kinds of actuators and operators has resulted in a highly developed and sophisticated state of the art of the design of such critical features as seals and mechanical power transmission.

Instrumentation for actuators and operators includes electrical position-indicating switches, potentiometers, and transducers and pressure-indicating switches and transducers. Designs for these devices reflect the requirements for exposure to severe environmental and operational conditions.

The monograph is based on a critical evaluation of the experiences and practices in the design, test, and use of these control devices and instruments in operational space vehicles. The material in the monograph is organized for natural and effective use by designers. Each of the devices is treated separately.

The monograph comprises two major sections: State of the Art, and Design Criteria and Recommended Practices. References complement the text.

The State-of-the-Art section reviews and discusses the total design problem, and identifies the design elements that are involved in successful design. The Design Criteria section states clearly and briefly each rule, guide, limitation, or standard that must be imposed on each essential design element to assure successful design; The Recommended Practices set forth the best available procedures for satisfying the Design Criteria.

Both major sections are divided into five subject categories: actuator configurations (piston actuators, diaphragm actuators, bellows actuators, solenoid and torquemotor actuators, snap-action actuators, rotary actuators, advanced concepts); operator configurations (pilot valves, servovalves, pressure dividers, advanced concepts); seals for actuators and operators (general conditions, dynamic seals, static seals, seal welds); mechanical transmission (common problems); and instrumentation for actuators and operators (general requirements, pressure measurement, position indication, temperature measurement, vibration-test measurement).

This thorough review of design criteria and practices relative to actuators and operators should be of value to designers and manufacturers of these devices and to designers and manufacturers of associated industrial equipment and instrumentation.

Notes:

1. This monograph is available as the following report:
   NASA SP-8090 (N74-17785), Liquid Rocket Actuators and Operators
   Copies may be obtained at cost from:
   Aerospace Research Applications Center
   Indiana University
   400 East Seventh Street
   Bloomington, Indiana 47401
   Telephone: 812-337-7833
   Reference: B74-10061

(continued overleaf)

2. Specific technical questions may be directed to:
   Technology Utilization Officer
   Lewis Research Center
   21000 Brookpark Road
   Cleveland, Ohio 44135
   Reference: B74-10061

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